ECE 6532 / CS 6640/ BIOEN 6640 Image Processing
Assignment 3

General guidelines:

- **Deadline: October 26, 23:59.**
- For book questions, reference for 3rd edition as well as International editions are provided. However, please make sure to validate question numbers in your book with a 3rd edition.

MATLAB question guidelines:

- Name the .m files with the same name as the function.
- You are not allowed to use any functions from the MATLAB Image Processing Toolbox or any other toolboxes in your methods. Only functions that are part of the basic MATLAB package may be used.

Submission guidelines:

- All submissions must be done using Canvas.
- The submission should contain exactly two files - report (pdf) and code + data (zip).
- Do not submit scanned hand written solutions.
- Answers to theoretical questions should be as concise and precise as possible.
- For programming questions, report should contain following:
  - You are required to explain your understanding of the question.
  - Technical details of the method such as any parameters used. If you find a specific value works best, a discussion on findings using other values is required OR the process involved in finding correct set of parameters. You are encouraged to play with different parameter values and discuss and findings.
  - Results and discussion: report the findings and discuss output images with respect to input images and expected output. It is preferable to add any contradictory results, if found, with brief comments about why it should/not be.
- Report would be used for evaluation and code might be verified for correctness as well as to match the results. Results in the report must correspond to results obtained from running the code.

QUESTIONS

1. Question 4.4 from the textbook.
2. Question 4.7 from the textbook.
3. Question 4.31 from the textbook.
4. Question 6.4 from the textbook.

5. Bandreject filtering

a) Implement the Butterworth bandreject filter. Your function should have the following format

```
function Io = ButterworthBandReject (I,Do,W,n)
```

where I is the input image, Do is the distance defining the middle of the band to be rejected, W defines the width of the rejection band and n is the order of the Butterworth filter.

b) Use the *fft2* command to take the Fourier transform of the images *house.pgm* and *houseNoisy1.pgm* (which is a noisy version of the former). Show the spectrums of the centered Fourier transforms (use *fftshift*) of these images. Use a logarithmic scale to display the spectrums Point out the differences between the two spectrums. What kind of noise is present in *houseNoisy1.pgm*?

c) What is the MSE of the image *houseNoisy1.pgm* compared to the original house image? *Note: In the rest of this quetion MSE always is compared to the original house image.*

d) Use a second order Butterworth bandreject filter to remove the noise from *houseNoisy1.pgm* as best as you can by choosing appropriate values for D_0 and W. Try to choose the parameters to get the best MSE for the filtered output. Report the D_o and W choices you found and the MSE of the output.

e) Compute and show the spectrum of *houseNoisy2.pgm*. How is the noise in this image different from *houseNoisy1.pgm*? What is the MSE of this image?

f) How would you use the Butterworth bandreject filter to remove the noise in *houseNoisy2.pgm* as best as possible? Explain your system, report its parameter values and the best MSE you were able to achieve.

g) Suggest another frequency filter which could remove the noise in these images as well as the bandreject but have better (lower) MSE and without causing ringing. Describe how you would choose the parameters of this filter. *Note: The answer is <u>not</u> an ideal band reject filter or higher n for the Butterworh band reject filter. It is something other than a band reject filter.*